

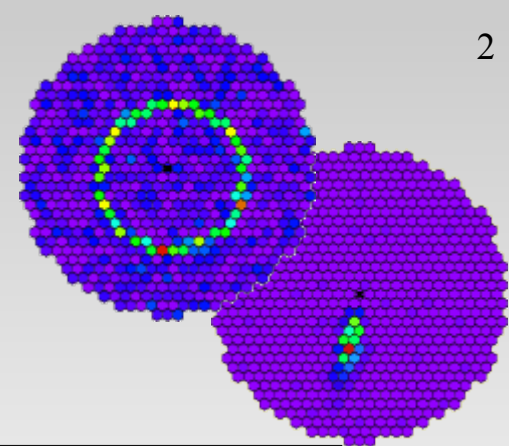
# The DWARF Network of Cherenkov telescopes for long-term monitoring of bright blazars

Thomas Bretz  
EPF Lausanne



# Motivation

Active galactic nuclei



- One of the important goals is to understand the extreme variability of AGN on time scales from minutes to years
- A possible explanation are, for example, binary black holes
- Natural expectation from hierarchical galaxy formation

[z.B. Begelman+80]



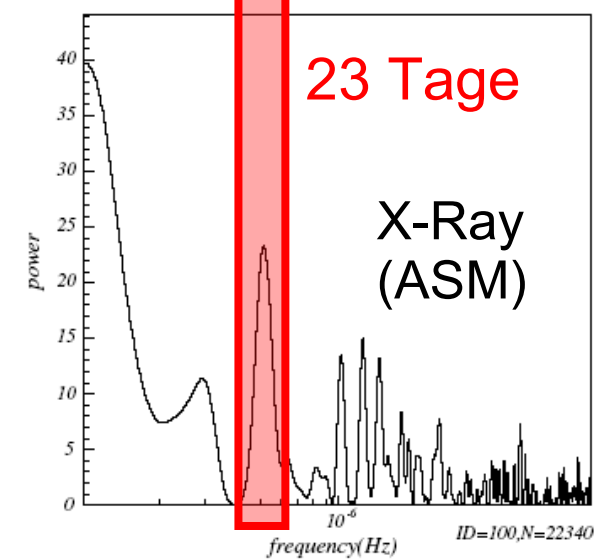
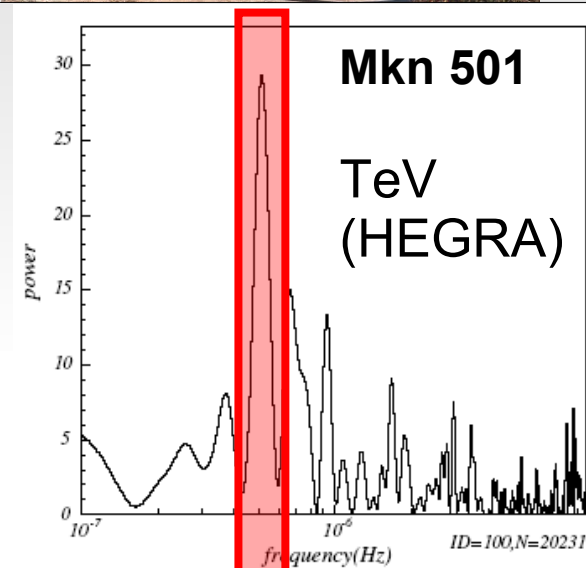
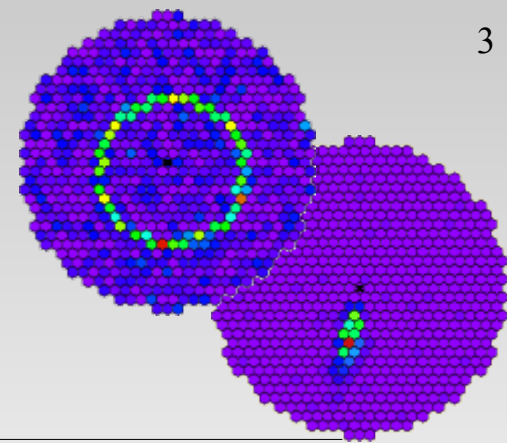
Chandra: NGC 6240  
 $z=0.024$ ,  $d \sim 1.4 \text{ kpc}$ ,  
2 aktive Kerne

[Komossa+03]



# Motivation

Active galactic nuclei



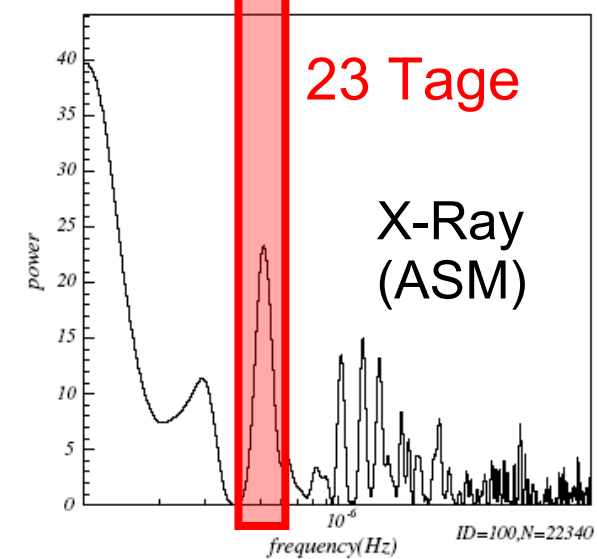
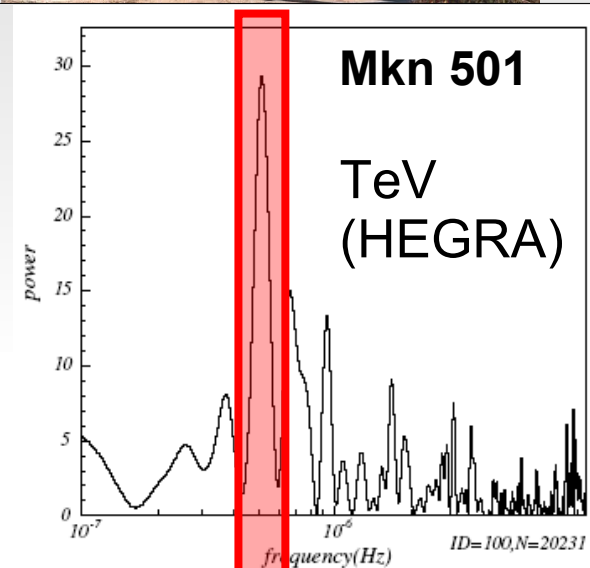
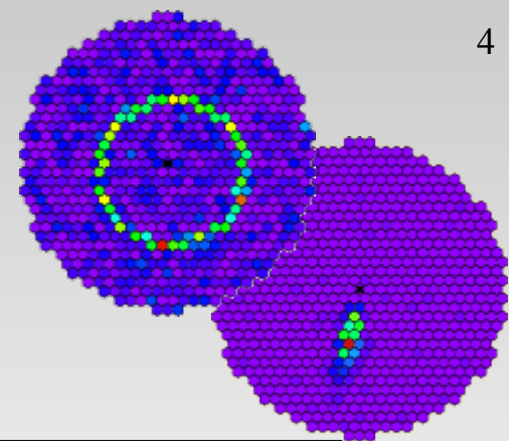
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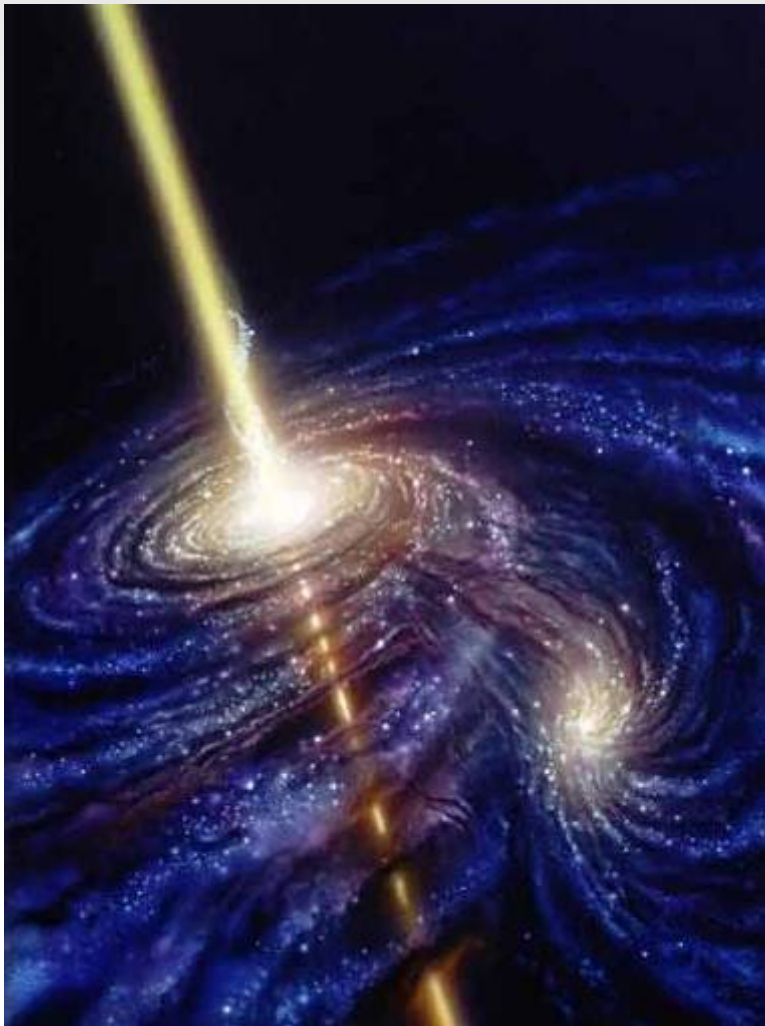
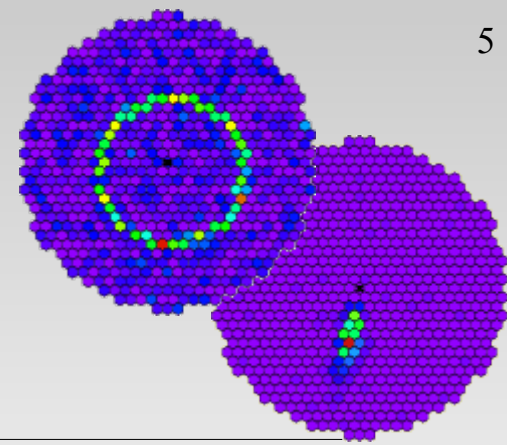
**Long-term observations mandatory!  $O(\geq \text{months})$**





# Motivation

Active galactic nuclei

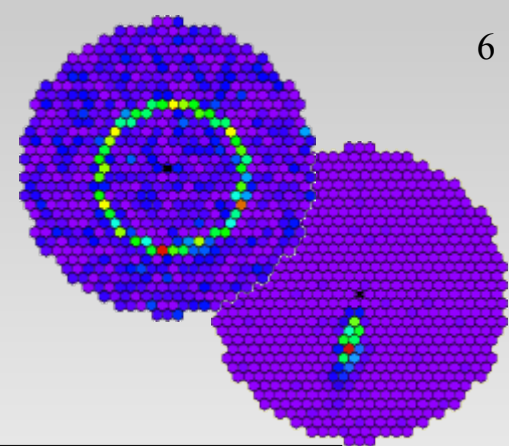


- Closely correlated (maybe the same):  
Better understanding of  
acceleration mechanisms  
(SSC, EC, Protonblazar, etc.)
- Especially correlations with  
neutrinos (IceCube)
  - + Clear hadronic signature!
  - + **ONLY** possible with monitoring!  
(Complete data sample needed)

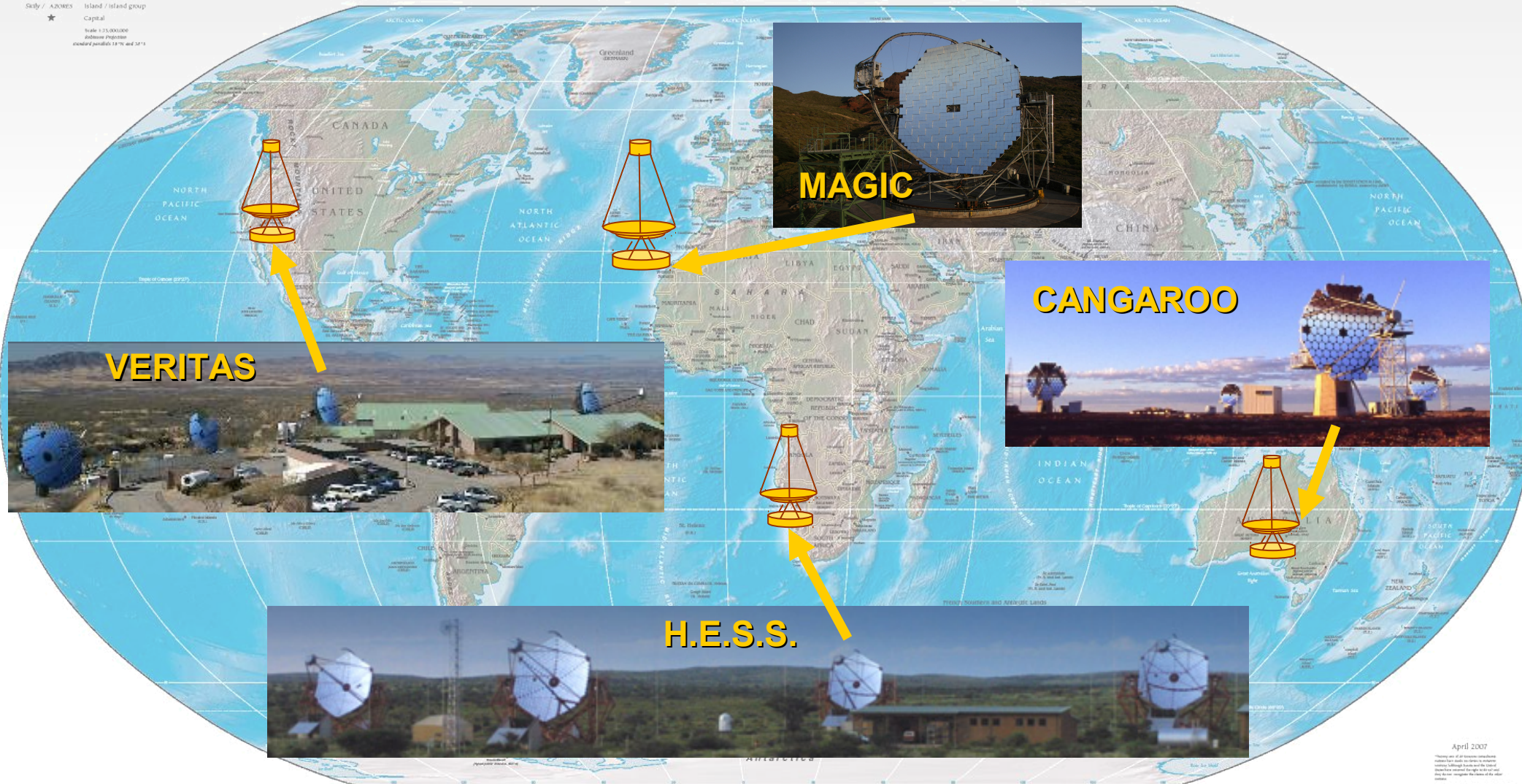


# Existing instruments

## Overview



Setby / AZWRES Island / island group  
★ Capital  
Scale 1:1,000,000  
Address Population  
Standard parallels 18°N and 32°S





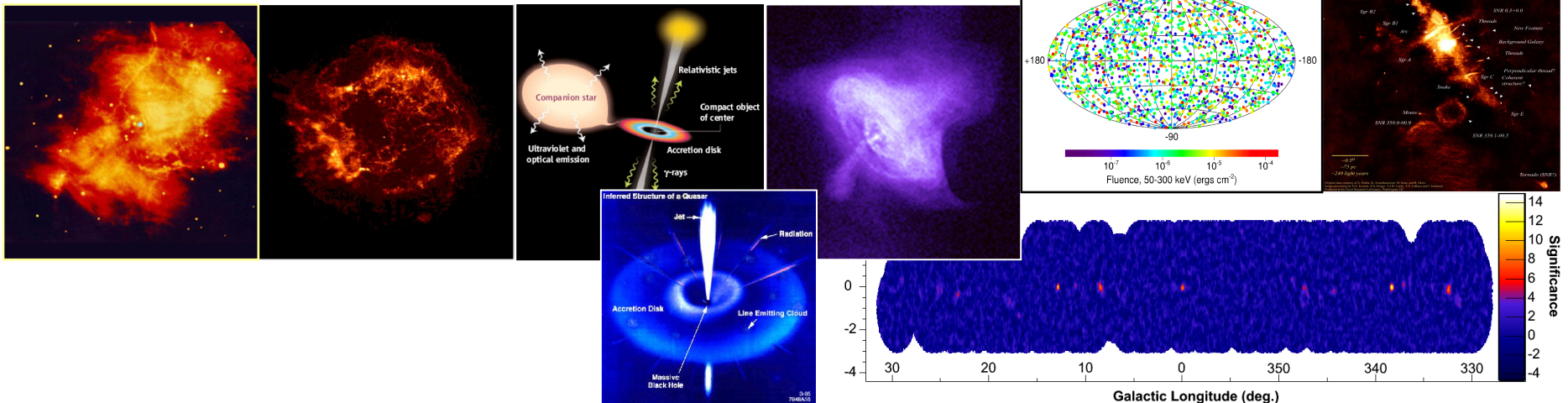
## High sensitivity and low energy threshold

- Pulsar-Wind-Nebula
- Radio galaxies
- Galaxy surveys

Supernova remnants  
Pulsars

# Microquasars Gamma-Ray-Bursts

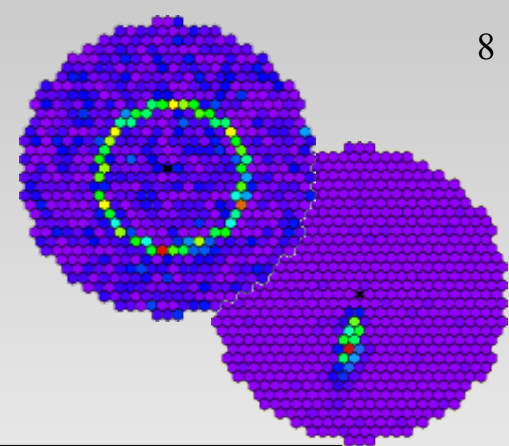
Galaxy clusters  
Blazars





# Existing instruments

## Overview



## High sensitivity and low energy threshold

- Mainly: search for new sources

Pulsar-Wind-Nebula

Radio galaxies

Galaxy surveys

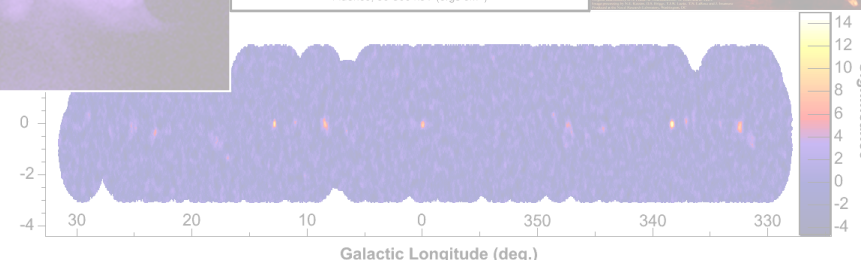
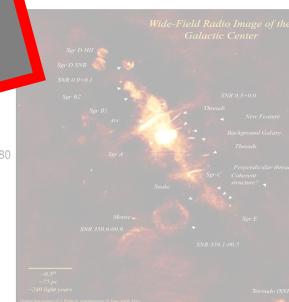
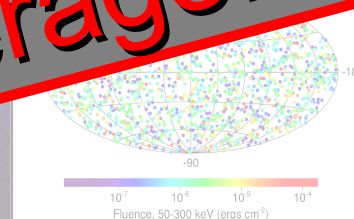
Supernova rem

Puls

Galaxy clusters

Quasars

**Too expensive!**  
**Bad time coverage!**

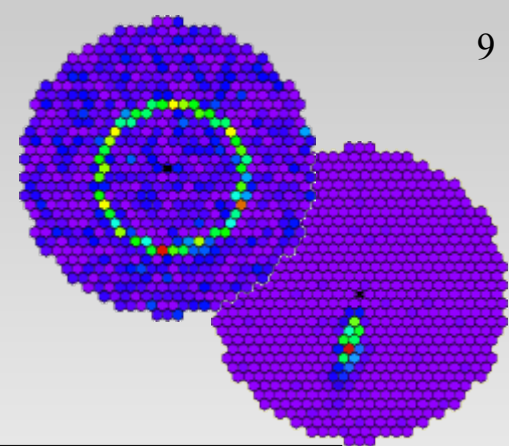






# The DWARF - Network

## Overview



- ★ The long term goal is a **Dedicated Worldwide AGN Research Facility** to obtain a really unbiased and complete sample!

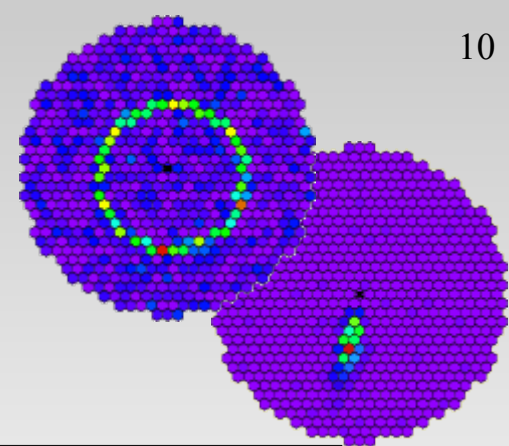




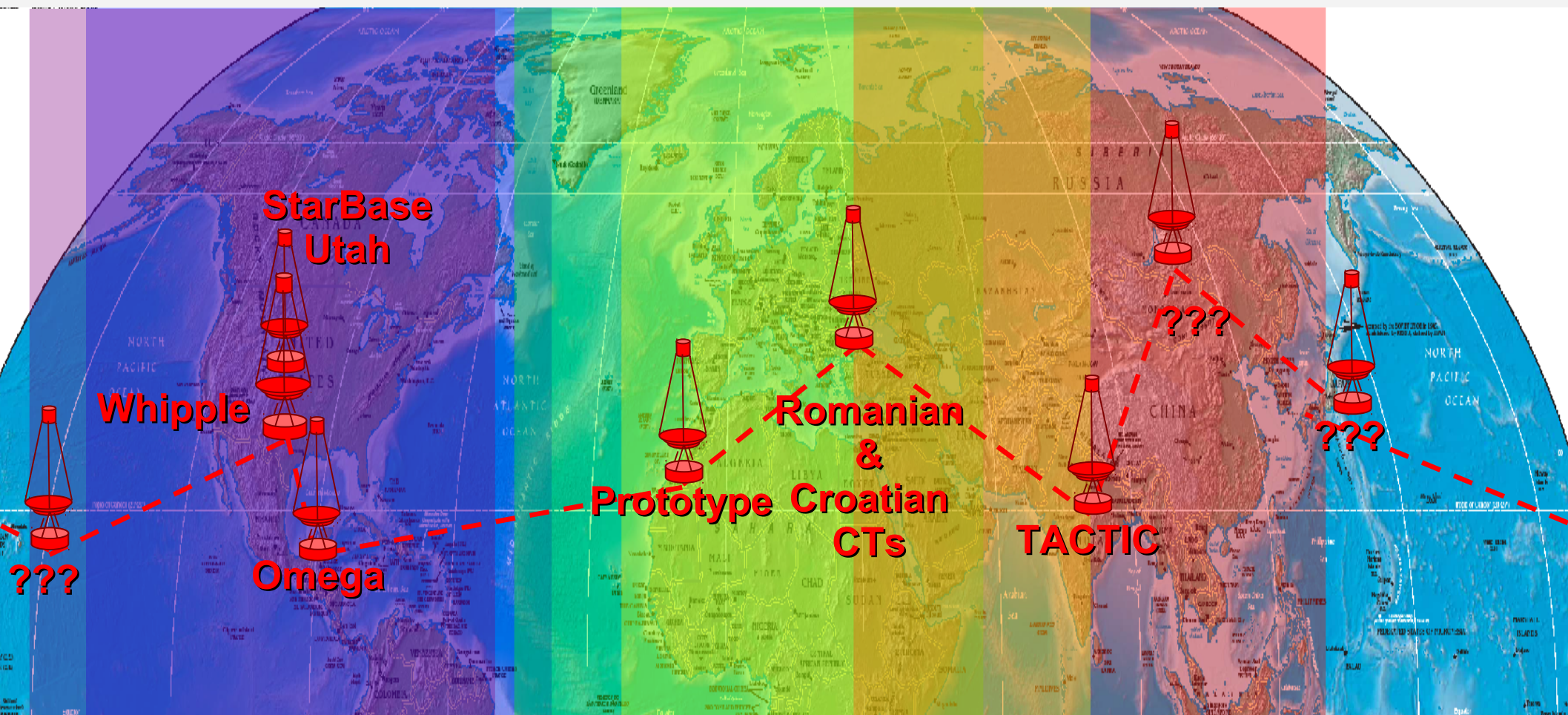


# The DWARF - Network

Time coverage



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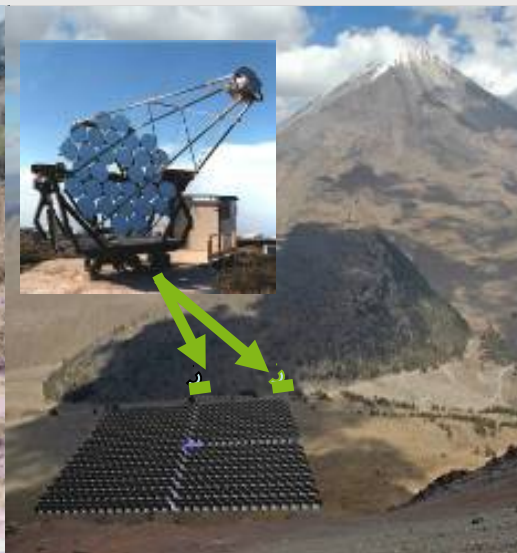
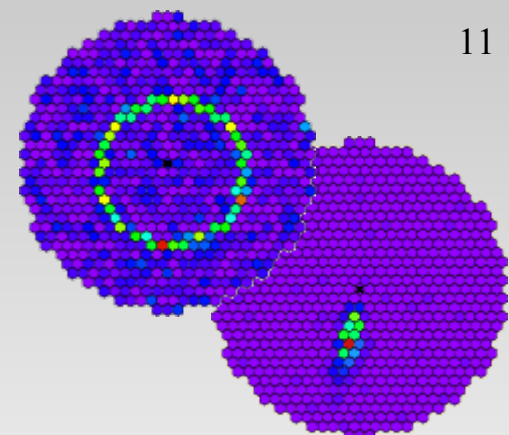






# The DWARF - Network

Available instruments



...  
more  
to  
come!

## Whipple 10m

- 1 telescope
- Mt. Hopkins (Az, USA)

➡  $E_{th} \sim 400\text{GeV}$

- Ongoing monitoring

[Pichel<sup>+</sup>, ICRC09]

## TACTIC

- 1 telescope
- Mt. Abu (IN)

➡  $E_{th} \sim 1\text{TeV}$

- Ongoing monitoring

[Koul<sup>+</sup>, *NIM* 07]

## OMEGA

- 2 of HEGRA
- Sierra Negra (MEX)
- 4100m a.s.l.

➡  $E_{th} \sim 700\text{GeV}$

- Ongoing construction

[Ruben<sup>+</sup>, ICRC09]

## StarBase

- 2 of Telescope Array
- Utah (USA)
- 7.1m<sup>2</sup> mirror
- Interferometry

- No Cherenkov camera yet

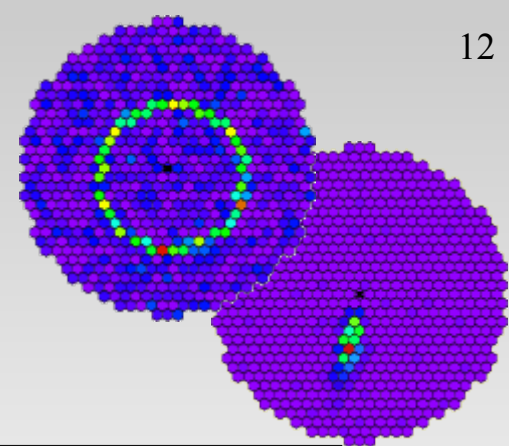
[Finnegan<sup>+</sup>, AIPC08]



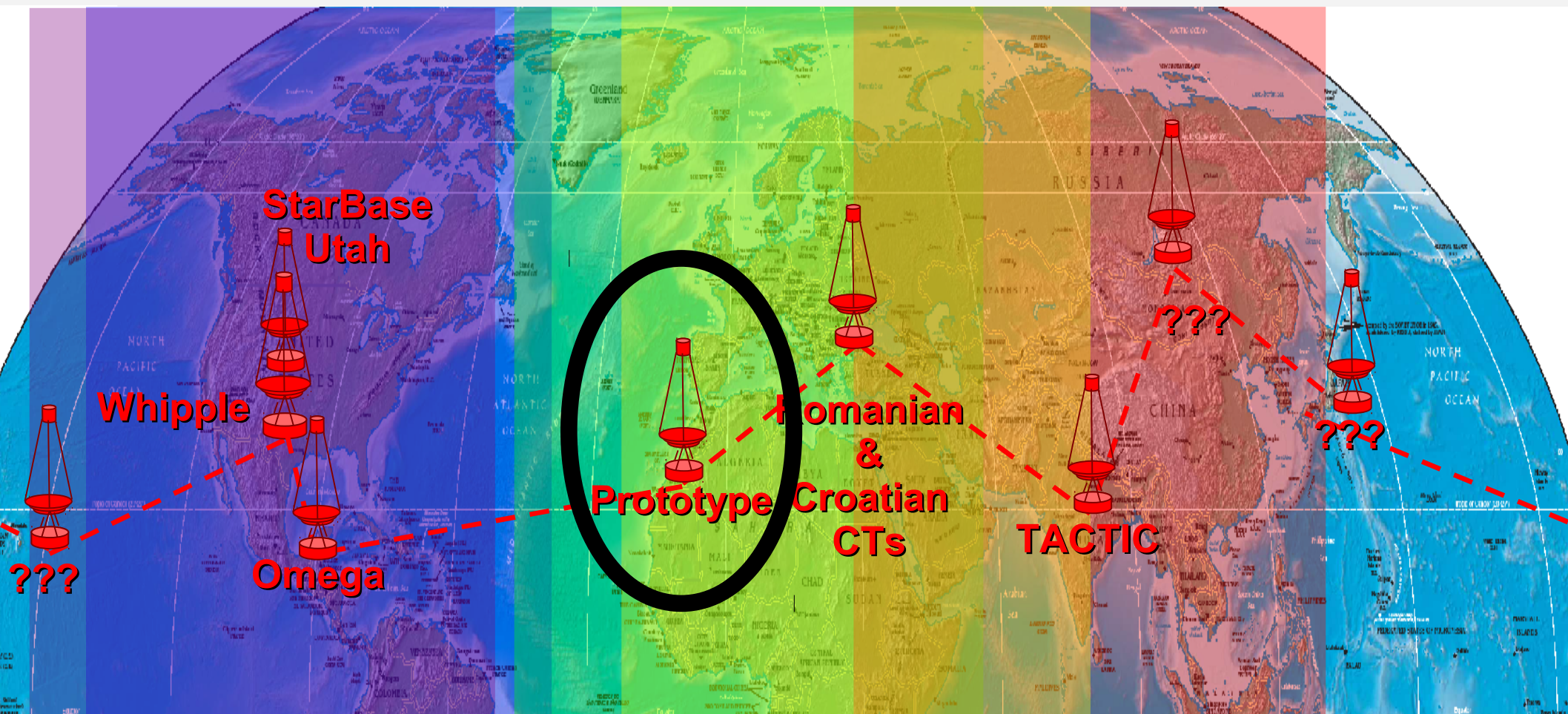


# The DWARF - Network

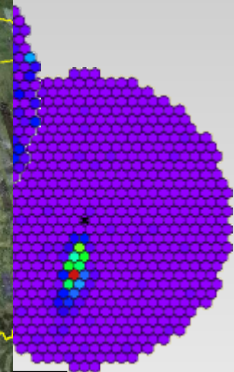
The prototype telescope



★ The long term goal is a **Dedicated Worldwide AGN Research Facility** to obtain a really unbiased and complete sample!



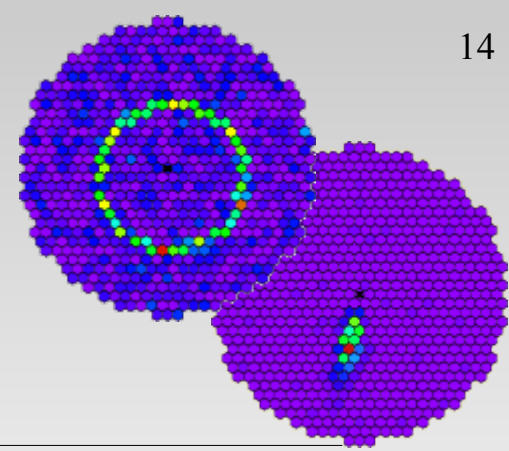








# The DWARF Prototype



**HEGRA CT3 at La Palma**



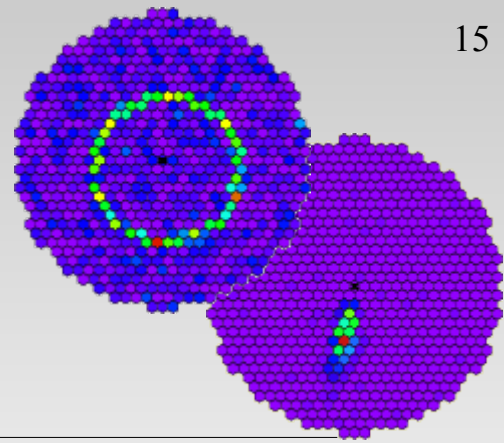
## The idea:

- Affordable monitoring telescope
  - observing a few target objects (Mkn421, Mkn501, ...)
  - with large duty cycles
- Refurbish one of the former HEGRA telescopes
  - switched off since ~2002
  - CT3 still at La Palma





# The DWARF Prototype



**HEGRA CT3 at La Palma**



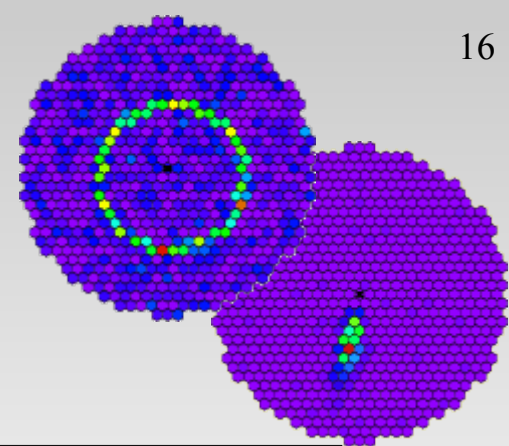
**Artist view**







# The DWARF Prototype



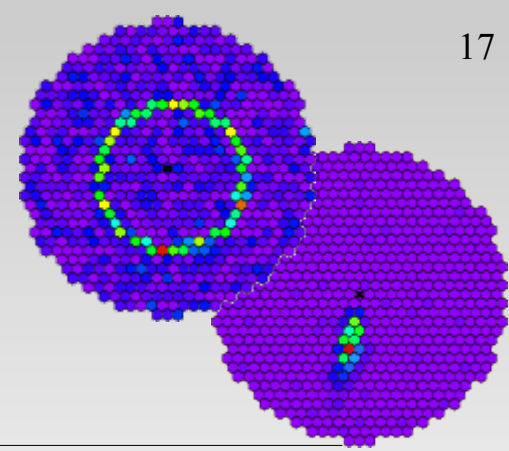
## Highlights of the upgraded telescope:

- High photon collection efficiency due to
  - first G-APD camera (prove of concept)
  - Solid light concentrators
- Integrated readout and trigger
  - DRS4 readout
  - Sum-trigger
- Increased robustness and maintainability
- Will be operated remotely





# Conclusion



- Long-term monitoring in the order of several month is important for the understanding of the acceleration processes in the vicinity of black holes
- A global network is currently set up to gain a good 24/7 time coverage allowing to get more continuous observation than with current instruments
- To increase the network with more telescopes a prototype for an affordable telescope is build on La Palma.



# Thank you!

**Monitoring: Important**

**Affordable telescope: possible**

**Performance: Reasonable**

**Network activities:  
ongoing**

# Dwarf